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Suggested limits to the use of the hot tub and sauna by pregnant women

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Because of reports of the potential risk of maternal hyperthermia to a developing embryo or fetus, studies were done to determine the length of time a woman must stay in a hot tub or sauna before her temperature reaches 38.9°C. The vaginal temperatures of 20 nonpregnant women of childbearing age were recorded while they sat in hot tubs set at 39.0°C or 41.1°C and in a sauna with an average temperature of 81.4°C. Five women were able to remain in the 39.0°C tub and six in the 41.1°C tub until their temperature reached 38.9°C, but in none did their temperature reach that level before 15 minutes in the 39.0°C tub or 10 minutes in the 41.1°C tub. The remainder left in discomfort while their body temperatures were lower. This indicates that the usual use of hot tubs is unlikely to raise a woman's body temperature to potentially teratogenic levels, although prolonged use may. None of the women were able to remain in the sauna long enough for their temperature to reach 39.9°C.

Suite à des rapports faisant état d'un risque pour l'embryon ou le foetus en développement pouvant résulter d'une hyperthermie maternelle, des études ont été conduites afin de déterminer la période de temps requise lorsqu'une femme reste dans une cuve thermale ou un sauna pour que sa température atteigne 38.9°C. On a enregistré la température vaginale de 20 femmes en âge de procréer mais non enceintes alors qu'elles reposaient dans une cuve thermale maintenue à 39.0°C ou 41.1°C et dans un sauna à une température moyenne de 81.4°C. Cinq ont été capables de rester dans l'eau à 39.0°C et six dans l'eau à 41.1°C jusqu'à ce que leur température ait atteint 38.9°C; cependant, en aucun cas cette température n'a pu être atteinte avant 15 minutes dans l'eau à 39.0°C ou en moins de 10 minutes dans l'eau à 41.1°C. Les autres femmes se sont retirées de la cuve thermale, jugeant celle-ci inconfortable, alors que leur température était plus basse. Ceci indique que l'utilisation habituelle d'une cuve thermale est peu susceptible d'élever la température corporelle d'une femme à un niveau possiblement tératogène, bien qu'un emploi prolongé en soit capable. Aucune des femmes n'a pu supporter le sauna suffisamment longtemps pour que sa température atteigne 38.9°C.

Hyperthermia has been shown to be teratogenic in animals, and recent retrospective studies have suggested that it may be teratogenic in humans.[1-11] The nature of the defects has varied with the time during gestation that the hyperthermia occurred; central nervous system problems affecting development and function have been the most serious consequence. The period during which teratogenesis is most probable is from about 3 to 15 weeks of gestation, and in most cases suspected of being related to hyperthermia it would have occurred during the first half of this period. The risk of a given level of hyperthermia at a given time of gestation has not been determined, but animal studies by Edwards have indicated that the lowest temperature that has any adverse effect

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is 1.5°C above the core temperature, which for humans would be about 38.9°C (M.J. Edwards, department of veterinary medicine, University of Sydney: personal communication, 1977). To date no morphogenetic problems have been recognized in infants who were exposed in utero to an increase in maternal temperature to less than 38.9°C.

For most of the relevant human cases the hyperthermia was caused by a variety of febrile illnesses in the mother. However, in several instances the only apparent exposure of the fetus to hyperthermia resulted from prolonged bathing by the mother in a hot tub or sauna. The question has therefore been raised as to the length of time a pregnant woman could safely spend in a hot tub or sauna. This study was designed to provide that information.

Subjects and methods

For this study 20 healthy, nonpregnant women of childbearing age volunteered to participate. Each subject was exposed to heat on 3 different days during a 7-day period and was asked to remain in the heated environment either until her temperature reached 38.9°C or until she was uncomfortable enough to want to leave.

A thermometer with insulated thermistor probes designed for an adult's rectum (Tele-Thermometer, Yellow Springs Instrument Co., Yellow Springs, Ohio) was used to record vaginal temperatures near the cervix. This "core temperature" was obtained in order to approximate the in utero temperature as closely as possible. Oral temperatures, taken with glass thermometers, did not correlate well with the vaginal readings, so were not used.

The two hot tubs were located at a commercial establishment that was able to provide reliably regulated water temperatures. One, with a water temperature of 39.0°C, was in a closed room. The other, with a water temperature of 41.1°C, was outdoors on a deck. The temperature of the surrounding air in each location was measured with a standard indoor–outdoor thermometer.

The temperature and relative humidity of the sauna were measured with a thermometer specifically designed for use in saunas. The average temperature during the experiment was 81.4°C, with a relative humidity of 15%.

Each woman's temperature was recorded before she entered the tub or sauna, every 5 minutes during her stay, immediately before she left the heated environment and, for most subjects, 10 minutes thereafter.

For each environment the data were separated into two groups: those for the women who had remained long enough for their temperature to reach 38.9°C and those for the women who had left because of discomfort at a body temperature lower than 38.9°C.

In the hot tub the subjects were immersed to the top of their shoulders. One subject repeated her stay in the 41.1°C tub with her arms and hands above the water surface.

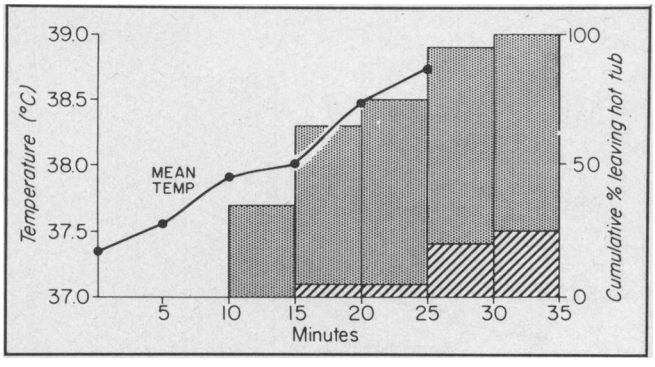

FIG. 1—Hot tub at 39.0°C: Line depicts mean vaginal temperature of two or more subjects at 5-minute intervals. Stippled area of bars indicates cumulative percentage of women who left because of discomfort before their temperature reached 38.9°C; striped area represents those who left after their temperature reached 38.9°C or more.

Results

The individual weight-to-height ratios did not correlate with the subjects' responses to heat. Most women over the age of 30 years tended to leave before their body temperature reached 38.9°C. There was no apparent correlation between the surrounding air temperature and the body temperature reached in the hot tub. The symptoms that the subjects reported as causing them to leave the hot tub or sauna included dizziness, tingling in the hands, rapid pulse, irregular heart beat and stomach pain.

After one woman had spent 20 minutes in the 41.1°C hot tub with her arms out of the water her temperature had not reached the level it had previously shown after 10 minutes in the same hot tub with her shoulders immersed.

Hot tub at 39.0°C

The subjects began to leave the tub because of discomfort after 10 minutes (Fig. 1), and the mean exposure time for those who left before their temperature reached 38.9°C was 15.3 minutes.

The five women whose temperature reached 38.9°C stayed in the tub from 15 to 25 minutes (mean 23.0 minutes). Their mean age was 24.4 years (mean age for all subjects 27.1 years).

Of the 16 subjects whose temperature was read 10 minutes after heat exposure, 4 showed no drop in core temperature and 4 an average rise of 0.2°C above the final reading in the heated environment.

Although the average rates of temperature rise progressively increased the longer the subjects stayed in the hot environment, there was much individual variation, with no uniform trend toward an accelerating rise in temperature.

Hot tub at 41.1°C

The subjects began to leave this tub after 5 minutes (Fig. 2), and the mean exposure time for those who left before their temperature reached 38.9°C was 12.1 minutes. The six women whose temperature

reached 38.9°C stayed in for 10 to 30 minutes (mean 18.5 minutes). Their mean age was 22.7 years. Of the 14 subjects whose temperature was read 10 minutes after their heat exposure, 4 showed no drop in core temperature and 2 showed a rise of 0.2°C. Again, there was much individual variation in the rate of temperature increase.

Sauna at 81.4°C

All of the subjects left in discomfort before their temperature reached 38.9°C (Fig. 3). They began to leave after 9 minutes (mean 12.9 minutes). Of the 13 whose temperature was read 10 minutes after their heat exposure, 7 showed an average rise above the final reading in the heated environment of 0.16°C.

Discussion

We conclude that healthy women of childbearing age can remain in a hot tub at 39.0°C for at least 15 minutes and at 41.1°C for at least 10 minutes without risk of their core temperature reaching a level that might cause a problem for a developing embryo or fetus (Fig. 4). This is a decidedly conservative estimate. Only one subject's body temperature reached 38.9°C within these times. If we omit the data from her two experiences, the earliest risk of hyperthermia would be 25 minutes in the 39.0°C tub and 15 minutes in the 41.1°C tub. Furthermore, the study did not allow for the behavioural thermoregulation that would be normal when hot tubs are used informally. For example, our subjects had to be reminded to keep their hands and arms immersed; there is a tendency to expose the arms to the air by resting them on the rim of the tub, and this practice slows heating, as we showed with one subject.

Retrospective studies of 170 cases of anencephaly, meningomyelocele and posterior occipital encephalocele revealed a history of hyperthermia during the week of neural groove closure (21 to 28 days) in an average of 10% of the mothers of these infants compared with none of a control group chosen from close relatives or friends of the mothers of affected infants and thus partially matched for social and geographic factors.[5,9,10]

Among 28 dysmorphic infants exposed to hyperthermia between 4 and 14 weeks' gestation all the survivors had mental deficiency and most had altered muscle tone, including hypotonia, with increased deep-tendon reflexes.[11] More of those exposed to hyperthermia at 4 to 7 weeks had facial defects. In 3 of the 28 pregnancies the hyperthermia was due to a long stay in a hot tub or sauna. In one instance the pregnant woman had remained in a tub that was reported to have a water temperature of 106°F (41.1°C) for nearly an hour. Two of us have already described the offspring of a woman who stayed in a sauna for a total of 35 minutes, with a 5 minute cooling-off period after the first 15 minutes.[4]

All of our subjects left the sauna and most left the hot tubs before their vaginal temperature reached 38.9°C because of discomfort due to the heat. This

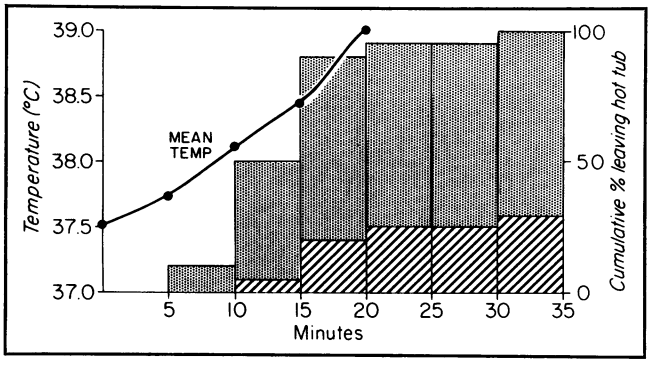

FIG. 2—Hot tub at 41.1°C: Explanation as in Fig. 1 legend.

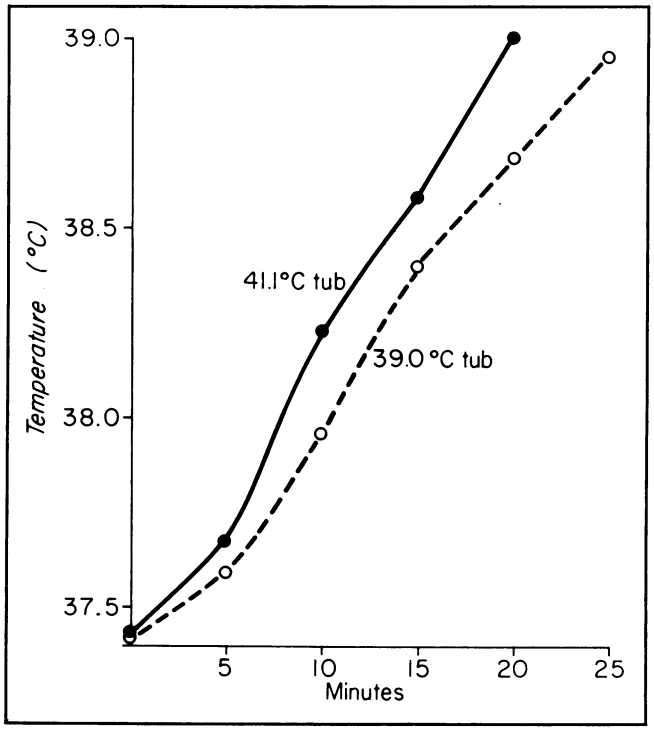

FIG. 3—Sauna at 81.4°C: Explanation as in Fig. 1 legend.

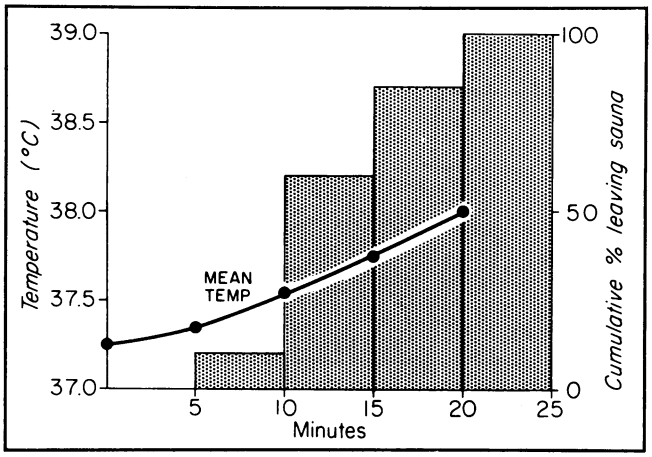

FIG. 4—Average vaginal temperatures of subjects who were able to remain in the hot tub until their temperatures reached 38.9°C.

indicates that the average nonpregnant woman would probably not remain in a heated environment long enough for her body temperature to reach the level suspected of being dangerous. Of 60 men and women aged 18 to 63 years the 13 who were able to remain in the sauna for 20 minutes had a rectal temperature higher than 39°C.[12] We were unable to use these data because the sex and age of those who remained in the sauna were not given, although it was noted that the mean exposure time and the mean rise in temperature were greater for the men.

An increased incidence of the fetal problems that could be associated with hyperthermia has not been recognized in Finland, where sauna bathing is common; however, our correspondence with Finnish physicians indicates that the average duration of sauna bathing for Finnish women is between 6 and 12 minutes. Furthermore, women in Finland normally tend to shorten their time in the sauna during pregnancy.[13]

The results of this study do not contraindicate sauna and hot-tub use during pregnancy. They do, however, suggest the wisdom of avoiding lengthy use, even when interrupted by short cooling-off periods, and indicate guidelines for the length of time a pregnant woman can remain in a heated environment before her temperature reaches a level that might be harmful to the embryo or fetus.

This information may be especially important at a time when the use of saunas and hot tubs is increasing in countries that, unlike the Scandinavian countries, lack the advantage of a long tradition of use to provide culturally set guidelines for the duration of pregnant women's exposure to the high temperatures.

We are grateful to the 20 women volunteers and thank George L. Brengelmann, MD, William A. La Framboise and Majorie E. Gamble, RN for their technical advice and assistance in obtaining the temperature-measuring devices. Alice Cunningham and Blair Osborn of the Olympic Hot Tub Company provided their spa equipment and cooperation, as did Mary Pearlman. Steven Simons, MD aided in data recording and Lyle M. Harrah served as research librarian.

This research received the following support: project 913, bureau of community health services, health services administration, public health service, Department of Health and Human Services; grant HD02274, National Institutes of Child Health and Human Development; grant HD05961, National Institutes of Health; and the medical research training program, University of Washington School of Medicine.

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In the next CMAJ

Alcohol and the fetus

A symposium on the effect of alcohol on the fetus contains three papers presented at "Alcohol and the fetus: a hearing of the scientific evidence", a conference held in Toronto in 1980.

Dr. Robert Sokol, of Case Western Reserve University in Cleveland, discusses why heavy alcohol consumption is an important risk factor during pregnancy and describes the fetal alcohol syndrome.

Drs. Henry Rosett and Lyn Weiner report on their study of the Boston City Hospital prenatal clinic program. They suggest that the existing health care system can be effectively modified to treat pregnant women who are problem drinkers.

In the third article Dr. Ruth Little, of the University of Washington in Seattle, and her colleague Dr. Ann Streissguth describe a spectrum of adverse effects on the fetus for a range of maternal drinking patterns.

What will BC doctors do next?

Medical writer David Wishart interviews BCMA president Dr. Ray March to find out why he and some other BC doctors voted against the settlement of a 40% increase in fees recently hammered out with the provincial government.